# “ A view of the past through the lens of the present. ”,

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« A view of the past through the lens of the present. Concluding remarks »,

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Following a decade of intense scholarship on the chemical revolution, over the past few years we have witnessed a striking revival of interest for early-eighteenth century chemistry. As Larry Holmes already pointed out in 1989, for many decades historians of chemistry have been mainly concerned with the emergence of modern science. As they were commenting and dissecting Lavoisier's published works and manuscripts they tended to consider eighteenth century as the "stage on which the drama of the chemical revolution was performed".[1] For them, early modern chemistry was nothing but pre-Lavoisieran chemistry.

This volume, which provides a sample of the most recent historiography of chemistry, testifies to the radical change of view that occurred over the past three decades. Early modern chemistry is interesting in itself. By scrutinizing the actual practices of chemists and paying attention to the multiple sites where chemical operations and demonstrations were performed in the early modern period, this volume gives an idea of what it was to be a chemist in the early modern period. On the one hand, the essays identify stable features beneath the changes of denomination from "alchemy" and "chymistry", to "chemistry". On the other hand, they try to highlight and understand the categories used by the actors themselves. This dual agenda triggers historiographical reflections on the broad question: how to write the history of science?

The concern with materials strikes me as one of the most obvious and permanent features in the ensemble of practices described in this volume. Whether they deal with metals, glass, acids or plants, the chemists here depicted are negotiating with the properties and behaviours of individual substances. In all cases their manipulations of materials - whether meant to transmute them or to use them for specific purposes - were intimately linked with cognitive goals. Chrysopoeia was a quest to understand the natural world and to make use of its powers (Principe, Roos). The success of Stahlianism in the mid-eighteenth-century relied not only on the theory of combustion but also on the study of acids and salts which offered both cognitive and practical advantages (Chang). Whilst making useful products

[1] Frederic L. Holmes, *Eighteenth-century as an Investigative Enterprise*, Berkeley, Office for History of Science and Technology, 1989, p. 3.

for medicine or for public welfare, most chemists at the same time tried to understand and predict the properties of the particular substances that they manipulated. This dual agenda was summarized by Herman Boerhaave (quoted by Powers) in the early eighteenth century: "When the Chemist explains to you the nature of glass, he at the same time teaches you a sure way of making it."[2]. Most papers suggest that the combination of crafts and science, of concerns with utility and truth claims, was a major feature of early modern chemistry.

On the other hand, a number of papers gathered in this volume follow Hélène Metzger's injunction to historians of science: they should position themselves as contemporaries of the works under study[3]. Together with Alexandre Koyré, she insisted that historians of early modern science should not project their own categories onto early modern science and rather had to forget about the present in order to uncover the meaning of the actors' categories. Many papers in this volume try to identify the criteria for being recognized as a chemist in a given context: either secrecy for Dr Plot (Roos), a combination of eloquence and material practices in the case of Libavius (Moran), condemning crafts secrecy in the case of Ignaz von Born while their skills (Dym), academic membership in the case of Geoffroy (Joly) collaborative academic work in the case of Macquer and Lavoisier (Lehman), the combination of manual skills with theoretical ambitions for the "philosophical chemist" of Diderot's *Encyclopédie* (Simon), combining botanical and chemical knowledge in the case of Olmedo (Powers). Together they provide a clear view of a science that had been overthrown, actively forgotten and rendered obscure, unreadable, non-intelligible to us by the focus on the origins of modern chemistry.

In this paper I would like to venture some historiographical reflections on the revival of interest for this period of chemistry. How are we to understand that a style of chemistry usually dismissed as being pre-modern or pre-scientific appeals to so many historians? What makes it so interesting in this early twenty-first century? I will argue that the early modern period regains our attention because the values attached to contemporary science are changing and the patterns of science in society are less and less alien to those of early modern chemistry. As Lucien Febvre, the founder of the *Ecole des Annales* noted: "Man does not remember the past; rather he always reconstructs it. [...] He does not keep the past in his memory, as the Northern ices keep millenary mammoths frozen. He starts from the present and it is through the present that he knows the past."[4] Since looking back to the past from the present is a "normal" attitude for historians, it is unavoidable to be sensitive to similarities between past and present situations. If early modern chemistry makes sense to us it may be because it resonates with some specific features of the present episteme. By the mid-twentieth century theoretical physics appeared as the model science while "pure science" was the most valued. Since the outset of decades of this century practical applications seem to the main driver of research efforts, partnerships between academia and industry are encouraged. Science policy is driven by a report significantly entitled "Society the endless frontier", as an echo to the famous 1945 report "Science the endless frontier".[5] Chemistry as an "impure science", a science that has always been engaged in productive practice, a science proud of being socially useful rather than confined in the arcane of theory, has a chance to be more highly valued than it used to be.[6]

I will first emphasize the striking similarities between the style of chemistry cultivated in the context of mid-eighteenth century France and the new cultures of chemistry that develop nowadays. I will

[2] Herman Boerhaave, *Elements of Chemistry*, Timothy Dallowe, trans., Vol. 1 (London: J. and J. Pemberton), p. 51.
[3] Hélène Metzger, "L'historien des sciences doit-il se faire le contemporain des savants don't il parle?, Archeion, 15, 1933, 34-44. Reprinted in Metzger La method philosophique en histoire des science. Paris Fayard, Corpus ds oeuvres philosophiques en langue française, 1987, pp. 9-21. See also Gad Freudenthal ed *Studies on Hélène Metzger*, Leiden, Brill, 1990.
[4] Lucien Febvre, *Combats pour l'histoire* [1952], Paris, Librairie Armand Colin, 1992, p. 14. "L'homme ne se souvient pas du passé; il le reconstruit toujours. L'homme isolé, cette abstraction; L'homme en groupe, cette réalité. Il ne conserve pas le passé dans sa mémoire, comme les glaces du Nord conservent frigorifiés les mammouths millénaires. Il part du présent et c'est à travers lui, toujours qu'il connaît."
[5] Parakskevas Caracostas, Ugur Muldur rapporteurs Society the endless frontier, European Commission/DG/XII R&D), Etudes, Luxembourg, OPOCE, 1997.
[6] Bernadette Bensaude Vincent, Jonathan Simon, *Chemistry, the Impure Science*, London, Imperial College Press, 2008. 2nd edition 2012 ?

point not only to the close interactions between knowing and making, academic knowledge and practical applications, but also to various commitments that go with this epistemic attitude: the social value and prestige attached to chemistry, the public engagement in chemical culture, the concern with recycling and even a specific relational ontology instantiated in the term "rapport". While the analogies between eighteenth century chemistry and the technoscience[7] of the turn of the twenty-first century drive the attention of historians they nevertheless may turn into obstacles when they end up in hasty rapprochements and whiggish interpretations of the past. In keeping with the attempts displayed in many articles of this issue to identify and understand the meaning to the actors' categories I will contrast the visions of the past and the future developed by eighteenth-century chemists and the concept of time that prevails nowadays. Early modern chemists did not have the same experiences of time as contemporary scientists, they lived in a different landscape, more precisely in a different "timescape". The concept of "regime of historicity", introduced by the French historian François Hartog, captures the special way of articulating the past, the present and the future that characterizes each society.[8] It is a useful conceptual tool to take a view of chemistry as embedded in a culture and integral part of the horizon of expectation of an epoch. On the basis of this contrast between the regimes of historicity I emphasize in conclusion the significance of assuming a historical relativity of our concepts of time (polychronism) - as an antidote to anachronisms. Whilst acknowledging the influence of the present on our interpretation of the past, it is important to keep the distance of the past, to experience the estrangement of historicity by historicizing the notion of time itself.

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*Science, arts et métiers*

In 1699, chemistry was officially established as one of the classes of the Paris Academy of Sciences along with Geometry, Astronomy, Mechanics, Anatomy and Botanic. Utility of science was the main feature set out by the first perpetual secretary of the Academy, Louis Bernard Lebovier de Fontenelle to legitimate the patronage of scientific research by the King. In the Preliminary Discourse to the *Histoire et mémoires de l'Académie* he stated that chemistry – then viewed as a branch of physics, the science of nature – was useful to "sustain life".

> "The utility of mathematics and physics, although in verity not obvious, is no less real for that. Considering man in a state of nature, nothing is more useful to him than that which can preserve his life, and that which can produce the arts. These arts are both a great aid to him and a great ornament to society. That which can preserve life belongs in particular to physics, and from this perspective, it has been divided into three branches in the Academy – making three different species of academician – Anatomy, Chymistry and Botany. It is easy to see how important it is to know the human body with exactitude, and the remedies one can draw from Minerals and Plants.[9]

[7] The Oxford English Dictionary defines technoscience as "Technology and science viewed as mutually interacting disciplines, or as two components of a single discipline; reliance on science for solving technical problems; the application of technological knowledge to solve scientific problems." This standard definition only provides the earliest meaning of the notion coined by the Belgian philosopher Gilbert Hottois in *Le signe et la technique. La philosophie à l'épreuve de la technique*, Aubier, Paris, 1984, p. 60-61. However in the 1980s, a number of philosophers and social scientists, who fought against the idealized view of a "pure science" detached from social, economic interests took up the term to refer to the true face of science constructed by a multitude of heterogeneous actors (Bruno Latour, *Science in Action*, Milton Keynes, Open University Press, 1987, p. 174). More broadly the term is currently used to denote a specific regime of research determined by science policy and oriented towards societal or economic demands. (B. Bensaude Vincent, *Les vertiges de la technoscience*, Paris la découverte, 2009) Thus the notion of technoscience denotes much more than the actual hybridization of science and technology. It is a new ideal of scientific practice, which no longer claims to be disinterested or neutral or amoral.

[8] François Hartog, *Régimes d'historicité - Présentisme et expériences du temps*, Paris, Seuil, 2003.

[9] "L'utilité des Mathematiques & de la Physique, quoiqu'à la verité assés obscure, n'en est donc pas moins réelle. A ne prendre les hommes que dans leur état naturel, rien ne leur est plus utile que ce qui peut leur conserver la vie, & leur produire les Arts, qui sont & d'un si grand secours, & d'un si grand ornement à la societé. Ce qui regarde la conservation de la vie,

While in the late seventeenth century the culture of science was essentially oriented toward curiosities, in the eighteenth century utility became the prime mover.[10] From this perspective, chemistry enjoyed a privileged status, because of its close connection to the manufacture of drugs, and many other products indispensable in everyday life such as ceramics, glass, glue, and metals. This utility, Fontenelle suggests, was more directly evident than that of astronomy, for instance. The prevailing view of science for public utility undoubtedly contributed to the prestige of chemistry in the French Enlightenment.

The close interaction between making and knowing that Ursula Klein has emphasized in a number of publications,[11] justifies the title of one of them "*technoscience avant la lettre*".[12] The use of the fairly recent notion of "technoscience" points to striking similarities between the style of chemistry that flourished in the eighteenth century and the new cultures of chemistry that developed in the late twentieth century. Both periods are marked by close interactions between knowing and making, between academic knowledge and practical applications, as well as by various commitments that go along with this epistemic attitude: the social value and prestige attached to research for society and public welfare, and by a public engagement in science.

However the interplay between cognitive and practical aims, which characterized eighteenth-century chemistry as well as contemporary technoscience, was designated by more appropriate phrases. In a time when scholars would never have dared forge a compound term mixing Greek and Latin roots (as happened with "technoscience"), the terms theory and practice were commonly used to characterize the Janus face of chemistry. Indeed Johann Gottschalk Wallerius, who held the chair of chemistry at the University of Uppsala, coined the phrases '*chymia pura*' and '*chymia applicata*'. Christoph Meinel argued that the above distinction based on goals played a strategic role in the legitimation of chemistry on the academic stage.[13] However, in France few chemists adopted the distinction between pure and applied sciences before the nineteenth century.[14] Instead in D'Alembert and Diderot's *Encyclopédie*, the authors operated with a threefold distinction between *science*, *arts* and *métiers*. Chemistry had a place in all three categories. The entry "chymie", authored by Gabriel François Venel, celebrated the dual nature of chemistry as science and art with general chemistry as the 'shared trunk' of a large spectrum of chemical arts. Venel insisted less on the conventional theme of science-improving-the arts preferring to emphasise the reciprocal contribution of the arts to the advancement of science. [15] In his view, the savant chemist could neither perform experiments nor draw general conclusions and

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appartient particulierement à la Physique, & par rapport à cette vûe, elle a été partagée dans l'Academie en trois branches, qui font trois especes differentes d'Academiciens, l'Anatomie, la Chymie, & la Botanique. On voit assés combien il est important de connoître exactement le Corps humain, & les remedes que l'on peut tirer des Mineraux & des Plantes". Bernard Le Bovier de Fontenelle, Discours préliminaire sur l'utilité des mathématiques et de la physique, *Eloge des académiciens*, 1699. See also Roger Hahn, *The Anatomy of a Scientific Institution, the Paris Academy of Science* 1666-1803, Berkeley, 1971.

[10] Clark W., Golinski J., and Schaffer S. (eds), *The Sciences in Enlightened Europe* (Chicago: University of Chicago Press, 1999); Stewart L., *The Rise of Public Science* (Cambridge: Cambridge University Press, 1992) ; On the culture of curiosities see Horst Bredekamp, *The Lure of Antiquity and the Cult of the Machine. The Kunstkammer and the Evolution of Nature, Art and Technology*, Princeton, Markus Wiener Publications, 1995.

[11] Ursula Klein, "The Laboratory Challenge: Some Revisions of the Standard View of Early Modern Experimentation" *Isis*, 99 (2008): 769-82. "Blending Technical Innovation and Learned Knowledge: The Making of Ethers" in U. Klein and E. C. Spary, eds., *Materials and Expertise in Early Modern Europe: Between Market and Laboratory*, Chicago and London: Univ. of Chicago Press, 2010), pp. 125-57.

[12] Ursula Klein "Technoscience *avant la lettre*" *Perspectives on Science,* 13, 2005: 226-266.

[13] Christoph Meinel, "Theory or Practice? The Eighteenth-Century Debate on the Scientific Status of Chemistry", *Ambix* , *30* 1983: 121-132.

[14] The distinction between pure and applied chemistry only prevailed in the post-revolutionary era with Jean Antoine Chaptal, *Chimie appliquée aux arts*, (Paris, Déterville,1807). Prior to this famous treatise, the term occurred in the title of one single rather chemical treatise: Dhervillez, and Lapostolle, *Plan d'un cours de chymie expérimentale, raisonnée et appliquée aux arts,* Imprimerie Veuve Godard, Amiens, 1777.

[15] "Les arts chimiques étant liés à la *Chimie* générale comme un tronc commun, il se présente ici deux questions très-importantes, ce me semble. 1. Jusqu'à quel point chacun de ces arts peut-il être corrigé & perfectionné par la science chimique ? 2 . Combien la science chimique peut-elle être avancée à son tour par les connoissances particulieres puisées dans l'exercice de chacun de ces arts ? Quant à la premiere question, il est évident que le chimiste le plus éclairé, le plus instruit, dirigera, réformera, perfectionnera un art chimique quelconque, avec un avantage proportionnel à ses connoissances générales, à sa science ; à condition néanmoins que sur l'objet particulier de cet art il aura acquis cette faculté de juger par sentiment, qui s'appelle *coup-d'oeil* chez l'ouvrier, & que celui-ci doit à l'habitude de manier son sujet ; car aucun moyen scientifique ne sauroit suppléer à cette habitude : c'est un fait, une vérité d'expérience". Gabriel François Venel, entry "chymie", *Encyclopédie* vol. III, Paris, 1753, p. 420.

predictions unless he had mastered the skills that the artisans (he termed them "artists") acquired through long experience of handling chemicals in the workshop. Venel advocated a sensorial empiricism based on the "*coup d'œil"*, the intimate knowledge of colours, smells, textures, and temperatures, which resulted from the *habitus* forged over a long period of practical experience.

> "In short, one needs to be an artist, a trained and experienced artist, if for no other reason than to be able to execute or direct different processes with the same facility, the same knowledge of resources, the same rapidity which make these operations a game, a pleasure and a captivating spectacle instead of a long painful discouraging exercise during which disheartening obstacles interfere and success is uncertain. All such isolated phenomena, these so-called bizarre operations, this variety of products and singularity of the results of experiments that half-chemists blame on the techniques of chemistry or on unknown properties of the materials they are working with can all be attributed to the artist's inexperience. They rarely occur with experienced Chemists. It is very rare, and perhaps it never happens, that a true chemist is unable to replicate a product using the same materials".[16]

While the impact of science on the arts consists in incremental progress, Venel claimed that the arts were the source of science: no chemical knowledge without knowhow, no broad view of chemical phenomena without paying attention to the details and circumstances of chemical operations. There is a striking asymmetry in his view of the interaction between science and the arts in favour of the arts.

To what extent, however, was this promotion of the value of the arts – typical of the *Encylopédie* – more pronounced in the presentation of the practices of chemistry than the other sciences? A detailed examination of the narratives of experiment at the Paris Academy of sciences in the eighteenth century by Christian Licoppe suggests a close link between the pressure to improve experimental practices and the concern with utility. In particular the reproducibility of results became a major requirement and criterion of validity at the Academy. Whereas at the turn of the century the culture of curiosities fostered the production of unexpected and spectacular effects and wonders, utility required the stabilisation and robustness of experimental data. In particular, Licoppe's analysis of Charles C. Dufay's memoirs on phosphorus shows how utility could influence the practice of academic research. The purpose of this series of experiments conducted in the 1720s was to establish that the light emitted by phosphorus was neither a wonder of nature nor a magic property of any particular phosphorus, such as the one from Bologna. He tried to demonstrate that all substances could be considered as phosphorescent provided they are prepared according to a simple and robust protocol.[17] And he promised that this common property would prove extremely useful.

The promises of utility could well have been just a rhetorical ornament, an excuse for conducting curiosity-driven research in an academic context, as is often the case for contemporary technoscientific research. However, the French government encouraged the links between science and the arts throughout the century. The members of the Royal Academy were regularly commissioned to find solutions to practical issues related to public health, urban life or agriculture.[18] The unification of laboratories with workshops was also institutionalized with the creation of academic positions in the

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[16] Ibid. "En un mot, il faut être artiste, artiste exercé, rompu, ne fut-ce que pour exécuter, ou pour diriger les opérations avec cette facilité, cette abondance de ressources, cette promptitude, qui en font un jeu, un délassement, un spectacle qui attache, & non pas un exercice long & pénible, qui rebute & qui décourage nécessairement par les nouveaux obstacles qui arrêtent à chaque pas, & sur-tout par l'incertitude des succès. Tous ces phénomenes isolés, ces prétendues bizarreries des opérations, ces variétés des produits, toutes ces singularités dans les résultats des expériences, que les demi-chimistes mettent sur le compte de l'art, ou des propriétés inconnues des matieres qu'ils employent, peuvent être attribuées assez généralement à l'inexpérience de l'artiste, & elles se présentent peu aux yeux du chimiste exercé. Il n'arrivera que très-rarement à celui-ci, peut-être même ne lui arrivera-t-il jamais d'obtenir un certain produit, et de ne pouvoir jamais parvenir à le retirer une seconde fois des mêmes matières". English transl. by by Lauren Yoder. University of Wisconsin http://quod.lib.umich.edu/d/did/did2222.0000.069?rgn=main;view=fulltext

[17] Dufay « Mémoire sur un grand nombre de phosphores », *Mémoires de l'Académie royale des sciences*, 1730, 522-535. Christian Licoppe, *La formation de la pratique scientifique, Le discours de l'expérience en France et en Angleterre (1630-1820)* Paris, la découverte, 1996.

[18] Bernard Joly's paper in this volume mentions expertise made by Etienne Geoffroy on technological issues.

royal manufactures. For instance, the Royal manufacture of tapestries - the Gobelins – created in 1731, was successively 'inspected' by Charles-François de Cisternay du Fay, Jean Hellot, Macquer and Claude-Louis Berthollet. All of these inspectors attempted to provide theoretical accounts of the operations performed by craftsmen in dyeing with the aim of improving or rationalizing their practices.[19]

In addition, public shows, museums, shops and workshops displayed chemical products and instruments for people to enjoy or to buy.[20] Recent studies of the chemistry courses delivered in Paris provide a new perspective on the interactions between science and the arts. Chemistry was so fashionable that fifty public and private courses were delivered in Paris in the 1750s and dozens in provincial cities.[21] The training of pharmacists and doctors was the primary motivation for the creation of public and private chemistry courses. In many cases the courses were delivered by a duo made up of a pharmacist and a physician, as medical doctors who were required to teach in full costume were not allowed to perform experiments.[22] The number of public and private courses increased over the century as the utility of chemistry and experimental demonstrations attracted a wider audience. According to John Perkins, about forty-five thousand people studied chemical science circa 1740 in France.[23] One of the most famous public courses was given at the *Jardin du Roy* by Guillaume François Rouelle from 1742 to 1764. It was attended by crowds of people from all social categories including ladies, the philosophes such as Rousseau, Diderot, Turgot, Condorcet, and leading figures of academic chemistry, Macquer and Lavoisier among others. Rouelle's public demonstrations are famous among historians of chemistry for being the vehicle for the propagation of Stahl's phlogiston theory.[24] However, it was certainly not Stahl's theory which attracted hundreds of people to the auditorium at the Jardin du Roy and dozens to Rouelle's private course on rue Jacob. His public demonstrations taught the art of making chemical preparations, and how to use the famous affinity tables that he had himself enriched to glassmakers, dyers, metallurgists and other artisans.[25]

Nevertheless not all metiers of chemistry were enlightened by theoretical science. There was also a great deal of anonymous amateurs performing experiments for fun or for entertainment. The *Gazette*, an early newspaper created in 1631 by the physician Théophraste Renaudot, which advertised chemistry courses, mentioned that Paris hosted practitioners of chemical operations who did not combine knowing and making. "Our paper would not suffice to make known in detail all those who burn charcoal in Paris in order to illuminate such-and-such a chemical truth, and a full folio would hardly suffice just to name those who burn charcoal without knowing why they do it."[26]

Paris also hosted crowds of obscure practitioners who performed routine chemical operations in more or less hazardous and unhealthy conditions. According to André Guillerme, a historian of chemical crafts in France, a huge number of workshops in Paris employed thousands of people with no

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[19] Hellot published *L'Art de la teinture des laines et des étoffes de laine en grand et en petit teint* in 1750; Macquer *L'Art de la teinture en soie* in 1763 and Berthollet *Éléments de l'art de la teinture*, Paris, 1791. See Agustí Nieto-Galan *Colouring Textiles. A History of Natural Dyestuffs and Industrial Europe*, Dordrecht, Kluwer Academic Publishers, 2001.

[20] Liliane Pérez, "Technology, curiosity and utility in France and in England in the Eighteenth Century" in B. Bensaude-Vincent and C. Blondel eds, *Science and Spectacle in the European Enlightenment*, (coll. Christine Blondel) Aldershot Ashgate, 2008, pp. 25-42

[21] Bernadette Bensaude-Vincent, Christine Lehman, "Public lectures of chemistry in mid-eighteenth-century France, in L. Principe ed, *New Narratives in Eighteenth-Century Chemistry* (Dordrecht: Springer, 2007) 77. John Perkins, "Creating Chemistry in Provincial France before the Revolution: The examples of Nancy and Metz, Part 1: Nancy," *Ambix* 50, 2003, 145-81, "Part II: Metz," 51, 2004, 43-75.

[22] Thus in Paris, the physician Pierre-Joseph Macquer taught with the apothecary Antoine Baumé; in Montpellier, Gabriel-François Venel, who was a physician, paired up with Jacques Montet; in the 1780s, the apothecary de La Planche started a new course with Jean-Baptiste Bucquet, a medical doctor.

[23] John Perkins, "Chemical Paris: laboratories and other sites, 1750-90" communication at the Conference Sites of Chemistry in the eighteenth Century, Oxford, Maison française, July 4 & 5, 2011

[24] Rhoda Rappaport, 'G.F. Rouelle, his *Cours de Chimie* and their significance for eighteenth-century chemistry', unpublished master's thesis, Cornell University (1958).'G.F. Rouelle: An eighteenth-century chemist and teacher', *Chymia* 6 (1960): 68-101. 'Rouelle and Stahl – the phlogistic revolution in France' *Chymia* 7 (1961): 73-102.

[25] Mi Gyong Kim, *Affinity, that elusive dream*, Cambridge: MIT Press, 2003. Lissa Roberts, "Chemistry on stage: G.F. Rouelle and the theatrality of eighteenth-century chemistry" in B. Bensaude-Vincent and C. Blondel eds, *Science and Spectacle in the European Enlightenment*, Aldershot Ashgate, 2008, pp. 129-140.

[26] *Gazette de Médecine* 1761, 199-200.

connection whatsoever to the academic milieu.[27] This rogue proletariat although indispensable for the chemical arts is omitted from the detailed descriptions of crafts such as metallurgist, glassmaker, hat-maker, dyer, or pharmacist to be found in Diderot's *Encyclopédie*. One merit of Guillerme's description of the chemical industries in Paris in the second half of the eighteenth century is to bring out the background role of collectors of raw materials: women, children, workers of the underclass wandered through the streets of Paris to collect ashes, rugs, urine, excrement and hair from houses as well as bones, skins and horns from the slaughter houses. The more that the population of Paris ate and consumed, the more the capital produced food and commodities. Thanks to the abundance and quality of water in Paris, an intense activity developed based on the recycling of all kinds of waste: urine was used to make volatile alkali; rugs were recycled to make paper, cardboard, and felt; decaying houses were the main source of nitre and used for the preparation of saltpetre; the blood of cows was calcinated with addition of potash residues of Prussian blue to prepare animal black; glue was made out of debris from sheep and veal skin, from claws, used gloves or clogs and the quality of the final product depended on the nature of the animal debris used. Ironically this pre-modern chemical industry based on biochemical operations such as maceration, fermentation, putrefaction, at room temperature and ordinary pressure corresponds better to the model of soft chemistry that has been developed over the past decades than the chemical industry of the past two centuries. However, this archaic biochemical economy could not meet all the requirements of today's chemical industries since it was neither clean nor healthy. The smell and the pollution in certain districts of Paris were so unbearable that following repeated complaints of neighbours the municipality banned all chemical workshops from the centre of the city and most of them re-located to the suburbs.

*Family resemblances in different regimes of historicity*

The search for resemblances between eighteenth-century and today's chemistry could be pushed further. In particular, parallels could be drawn at a more abstract level of epistemology and ontology. The systematic campaigns of experiments of displacement reactions performed by eighteenth-century chemists to set out the tables of affinity could be compared to the systematic exploration of the combinatorial practices used in contemporary chemical and pharmaceutical industries. The ontological status of the substances included in the *tables de rapports* – defined by their inter-relations rather than by their compositions – could serve as a model for improving the definition of nanoparticles since their properties and behaviours seem to depend almost exclusively on their surface area and consequently on their reactivity.[28] Just as eighteenth-century chemists focused on the dispositions of chemicals and their interactions, nanotechnologists could well refocus their investigations on the dispositions and interactions of nanoparticles rather than on their technological performances[29]. However, the purpose here is neither to draw lessons from history nor to provide guidance for active nanoscientists and science policy makers.

Instead, I would like to develop some historiographical reflections about this parallel between eighteenth-century and contemporary chemistry. Generally, when we can identify a family resemblance between two individuals belonging to distinct generations, we can conclude that they might share at least a few genes. No such inference can be made about patterns of research unless we assume the existence of genes or their equivalent in scientific disciplines. Instead of essentializing disciplines such as chemistry in this way, we suggest comparing the cultural heritage transmitted from generation to generation to a sort of "language game", which is part of a broader "form of life". Thus, we would argue that Ludwig Wittgenstein's concept of "family resemblance" – denoting loose analogies connecting particular uses of the same word without assuming any common essence – is

[27] André Guillerme, *La naissance de l'industrie à Paris, entre vapeurs et sueurs* (1780-1830), Seyssel, Champ Vallon, 2007. See also Sabine Barles, *La ville délétère : médecins et ingénieurs dans l'espace urbain*, Seyssel, Champ Vallon, 1999.

[28] Lissa Roberts, Setting the Table: the Disciplinary Development of Eighteenth-Century Chemistry as read through the Changing Structure if its Tables", in Peter Dear ed., *The Literary Structure of Scientific Argument*, Philadelphia: University of Pennsylvania Press, 1991, p. 99-132. On the ontological status of chemicals see Bensaude Vincent and Simon, *Chemistry, The Impure Science*, op. cit. chapter 12.

[29] Sacha Loeve, B. Bensaude-Vincent, F. Gazeau, "Nanomedicine metaphors. The emergence of an oecological approach", *NanoToday*, 2013 (in print)

more appropriate in this context than talk of genes.[30] The cultural heritage of chemistry built around the space of the laboratory, with recipes, protocols, methods, concepts, etc. undoubtedly shaped a recognizable identity of chemistry. However, the practices inherited by means of cultural heritage are shaped by the historical context where they are enacted. In particular, the identity of chemistry is continuously reshaped according to the way its practitioners envisage their position in history.

In his article Jonathan Simon suggests that it might be more fruitful to describe an object of study in terms of *what it is not* rather than in terms to what it is. Here I would like to take a similar approach. Emphasizing differences rather than similarities between eighteenth-century and contemporary experiences is a methodological approach aimed at preventing tacit projections of our concepts and concerns onto past science. Recent historiographical research shows that the vision of time is a cultural construction. Each society has a special way of articulating the past, the present and the future. The notion of regime of historicity forged by François Hartog is a tool for characterizing the order of time created in each culture. Time is not a universal metaphysical entity but rather the experience that people have in a context, how they envision the relations between the past, the present and the future. "A regime of historicity is nothing more than a way of engaging with the past, the present and the future or combining the three categories in some manner." [31] In the early eighteenth century, time was still experienced as the cyclic repetition of heroic moments, or exemplars. The famous image of "dwarfs on the shoulders of giants" gives a sense of the regime of historicity that prevailed before the emergence of the modern notion of revolution. According to Reinhart Koselleck, it is around the late eighteenth century that the modern notion of history (*die Geschichte*) emerged in Prussia.[32] The past started to be seen as a vector made of unique events and oriented toward the future. In France, the French Revolution of 1789 is considered as the turning point when the notion of revolution ceased to be understood as a cyclic movement and came to denote a radical break with the past. History then became an experimental field open to the future rather than the narratives of heroic moments that provided guidelines for the future. Bernard Joly's portrayal of Geoffroy in this volume instantiates the pre-modern regime of historicity. In his exploration of the links between the alchemical tradition and the more recent tradition of mechanical chemistry cultivated at the Paris Academy of Science, Geoffroy never assumed a radical break with the alchemical past. He rather tried to promote innovations as the continuation of a longstanding quest that required the continuous efforts of many generations. He was not unique in considering the present and the future as the continuation of the past. In the article "chemistry" of Diderot's *Encyclopédie*, Gabriel François Venel created a horizon of expectation by expressing the wish for "a New Paracelsus" who would bring about a revolution in chemistry.[33] However his view of revolution was nothing like a break with the past or the present. Instead, Venel called for a hero capable of restoring the high profile of chemistry. His vision of the future was shaped by the heroic past and his concept of revolution suggested the repetition of an epochal moment, a landmark providing guidelines for the future. It thus becomes clear that most eighteenth-century chemists did not need grand narratives of change built on broad revolutionary claims.[34] It is only in the course of Lavoisier's career that the term revolution came to refer to a radical beak with the past. In his "*Réflexions sur le phlogistique*" of 1785, Lavoisier explicitly invited the reader to forget about the past and to assume that phlogiston had never existed.[35] In this way, the future became the reference point, providing guidelines for the present and a teleological framework for rewriting the history of the past. Therefore there is no such thing as a "technocience avant la lettre" because the concept of technoscience is tightly associated to an "economy of promises" which subordinates the future to the present, which frames the future according to today's prevailing values.

There is a striking contrast between these two regimes of historicity and the current experience of time

[30] Ludwig Wittgenstein, *Philosophical Investigations*, Blackwell, 1958, §§ 66-67, p. 32e.
[31] François Hartog, *Régimes d'historicité. Présentisme et expérience du temps*, Paris, Seuil, 2003; 2nd ed. 2012 p. 14. 'Un régime d'historicité n'est ainsi qu'une façon d'engrener passé, présent et futur ou de composer un mixte des trois catégories.'
[32] Reinhardt Kosseleck *Future Pasts: On the Semantic of Historical Time*, Columbia University Press, 1985.
[33] Gabriel François Venel, entry 'Chymie », in Diderot ed Encyclopédie
[34] I.Bernard Cohen, *Revolution in Science*, Boston, Harvard University Press, 1985.
[35] Bernadette Bensaude Vincent, *Lavoisier. Mémoires d'une révolution*, Paris, Flammarion, 1993.

in today's technosciences, which are primarily focused on the present. The past no longer sheds a light on the present or the future. It is only viewed as a document, a trace or a monument. The past is divorced from the present, completely detached from what is going on now. Traces of the past are certainly kept as sanctuaries of a defunct world but there is no lesson to be drawn from the past. Each emerging technology claims to bring about a new revolution, the nth Industrial Revolution. However neither is the future the goal determining the present as it used to be in the twentieth century. In the modern regime of historicity, which prevailed between 1789 and 1989 (symbolic date of the fall of the Berlin Wall) according to Hartog, the future shed a light on the present and on the past. Now the present sheds a light on the past and on the future. The faith in progress, the belief that tomorrow would be better than yesterday and even today, has given way to a kind of anxiety about the future. Indeed, research and development in nanotechnology and biotechnology are still officially made in the name of the future with such promises as food for all, energy, new diagnostic techniques and therapies, longevity, etc However, this future is no longer an *avenir radieux*, a bright future lighting up the temporal horizon. Rather biochemical technologies are promoted as attempting to remediate the problems (pollution, scarcity of resources) caused by the development of synthetic chemistry and a frantic rhythm of innovation and productivity. The main concern is to maintain the present state of affair, to continue business as usual. Even nature is treated as a heritage that needs to be preserved. In this regime, where the present is indefinitely extended, inflated and omnipresent, the meaning of chemistry has radically changed. Whereas in the eighteenth century chemistry was a popular and fashionable science in harmony with the prevailing values of the Enlightenment (public good and perfectibility), today chemistry is perceived as a major cause of pollution and a threat to the future of atmospheric air, the climate, and human health. In the early twenty-first century there are no longer any chemical plants in Paris. Chemical factories have largely been delocalized to emerging countries, and the consumption of chemicals and plastics continues to increase. Chemistry has to be made invisible because it is at odds with the prevailing concern to preserve nature instead of celebrating the transforming power of technology.

*Polychronism vs anachronisms*

The purpose of this parallel between early modern chemistry and the technosciences in which today's chemists are exercising their professional skills is to disentangle a methodological puzzle in the practice of history of science. At first glance, looking at the past through the lenses of the present seems to challenge the movement of antiwhiggism, which has eroded the bias view of early modern as pre-Lavoisieran chemistry over the past decades.[36] If alchemy is no longer an obscure mystical set of beliefs and images, if eighteenth century chemistry is more than a stage to perform the drama of the chemical revolution, it is undeniably because two generations of professional historians got rid of the narratives forged by the scientific winners. It was impossible to capture the meaning and restore the consistence of early modern practices of chemistry as long as the chemical revolution was viewed as the necessary outcome of the truth and legitimacy of Lavoisier's chemistry.
However to gain an insight in obsolete science, to restore its significance and consistence historians do not have to retreat in an ivory tower and work in isolation from their time. One can follow Metzger's efforts to make herself the contemporary of the works under study without forgetting about contemporary science and without adopting a puritan attitude of abstention and abstraction from the outside world. It is illusory to think that we can exclude all forms of presentism. The patterns and the values of present-day science certainly influence the topics and periods that we elect to investigate as well as the terms that we use to describe the past. In history as in natural sciences, there is no objective perspective from nowhere or no-time. Far from being neutral, disinterested or dispassionate historians of early modern science need to engage with their subjects as they have to actively counteract the discredit of the losers and to come out with a more positive view of their achievements.[37] Whatever the

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[36] The notion of whig history derived from British political history has been introduced in the history of science by Herbert Butterfield (*The Whig Interpretation of History*, London, 1931) and later discussed. See John Schuster, *The Scientific Revolution. Introduction to the History and Philosophy of Science*, chapter 3 "The problem of whig history in the history of science" Open Learning Australia 1995. Nicholas Jardine, "Whigs and stories. Herbert Butterfield and the historiography of science", *History of Science*, 41, 2003, 125-140.
[37] The famous principle of symmetry in the analysis of controversies formulated by STS scholars – paying equal attention

personal empathy of historians for their subjects, this valuation is made possible by present-day concepts and controversies. The valuation of the role of craftsmen and of social utility in early modern chemistry resonates with the values promoted in contemporary technosciences. And the controversies raised by this regime of knowledge suggest that the old values of pure science are still alive. Therefore the most powerful antidote against whiggism is not to forget about present-day science but to be aware of the influence of the present on historical practices.
However to avoid the unconscious imposition of current categories on the works of past chemists who ignored them (anachronism), we have to go further and be also aware of the historical multiplicity of historical concepts of time (polychronism). In the essay where she discussed the question “Should the historian of science make herself the contemporary of the scientists under scrutiny?” Metzger herself acknowledged that it is an impossible task. As she pointed the various obstacles to a full understanding of the works of early modern chemists, she anticipated the idea of incommensurability later introduced by Thomas Kuhn and Paul Feyerabend independently. Basically it is impossible to fully grasp their concepts and to compare paradigms because they are based on different assumptions, values and worldviews. The concept of incommensurability has to be extended to our experiences of time. To erode the whiggish idea of the accumulation of scientific knowledge with the passage of time, it is vital to question the very notion of “the passage of time”. Although the image of the time arrow and the progress of mankind is deeply engrained in our mentality it is by no means an impermanent reality. It is a historical construction submitted to revisions which encourages a critical attitude to the present as much as to the past. The identity of chemistry has been framed – and is still being reconfigured - through a variety of timescapes.

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and respect to the losers and the winners – cannot overlook that the winners’ views have gained legitimacy and shaped the future. See Latour *Science in Action*, Harvard University Press, 1987. Isabelle Stengers, C*osmopolitics 1,* University of Minnesota Press, 2010.